Electrochemical and Electrogravimetric Behavior of Composite Formed by Polyaniline and Vanadium Pentoxide

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The V_2O_5 xerogel films show a high insertion level of Li^+ ions and a high potential vs Li, resulting in a high specific capacity and a high energy density [1]. Besides these properties, the V_2O_5 xerogel films can be easily prepared from vanadium alcoxides precursors [2]. Despite these vantages, this oxide has some limitations such as a low conductivity, a slow Li^+ diffusion into host matrix and irreversible changes during the long time charge/discharge cycles. In fact, significant progress can be obtained from the synthesis of new host lattices, where the guest can be easily intercalated/deintercalated without loss of the charge capacity with the cycle number and a lower ohmic drop. Thus, a possibility for the optimization of this oxide is the synthesis of nanocomposites from vanadium oxide, V_2O_5, and polyaniline, PANI, an electronic conductor polymer [3-7]. These nanocomposites are formed from distinct components, which have an intimate contact between them in nanometric scale.

In this work, it was synthesized V_2O_5 and the PANI/V_2O_5 hybrid material, which involved simultaneous polymerization of both, the aniline monomer and the inorganic oxide. Using FTIR measurement was carried out the characterization of both materials. Electroacoustic impedance measurements on the quartz crystals were run in order to verify the mechanical proprieties of the films and if the Saurbrey equation could be used. The electrochemical quartz crystal microbalance (EQCM) was employed to identify the species involved in the charge compensation process. Finally, the cyclability of the films was discussed as a function of their structural aspects, indicating the influence of PANI in the V_2O_5 host matrix.

Figure 1 shows j/E and Δm/E potentiodynamic profiles at 5 mV/s for $[PANI]_{0.3}V_2O_5$ in 0.5 M $LiClO_4$/PC electrolytic solutions. The $[PANI]_{0.3}V_2O_5$ film has a greater electroactivity than the $V_2O_5.nH_2O$ film. This gain of the electroactivity provoked by PANI is attributed to higher diffusion of Li^+ into the structure. The charge compensation process was verified through the mass changes, and the shape of this curve indicates a major participation of Li^+ in the redox process of the $[PANI]_{0.3}V_2O_5$ film. Besides this, the solvent intake/uptake is considerable smaller than in the case of V_2O_5.

The intake/uptake of PC into of the structure during the Li^+ intercalation/deintercalation process promote the expansion/contraction of the lattice. These volumetric changes after many charge/discharge cycles produce irreversible structural changes. Figure 2 illustrates the cyclability of the V_2O_5 and $[PANI]_{0.3}V_2O_5$ films. It is noted that the charge capacity of the V_2O_5 film after 150 cycles decreases 50% of the initial charge capacity. By other hand, the $[PANI]_{0.3}V_2O_5$ film decreases only 20% of the initial charge capacity. The better

cyclability of the $[PANI]_{0.3}V_2O_5$ film is related to a diminution in the expansion/contraction of the lattice during the redox process, decreasing any irreversible degradation.

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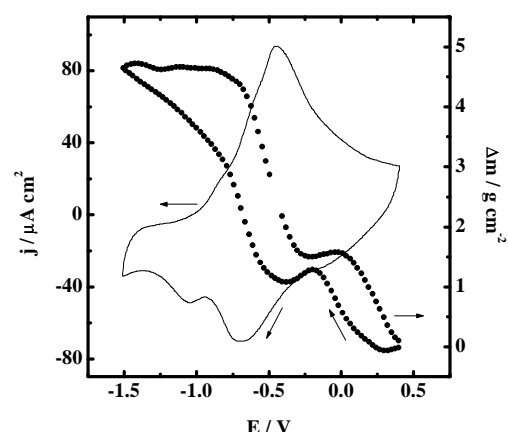7. F. Huguenin, M. T. P. Gambardella, R. M. Torresi, S. I. C. de Torresi, and D. A. Buttry, J. Electrochem. Soc. 147 (2000) 2437.

Figure 1 – Potentiodynamic profiles j/E (full line) and Δm/E (dotted line) for $[PANI]_{0.3}V_2O_5$ in 0.5 M $LiClO_4$/PC. v = 5mV/s.
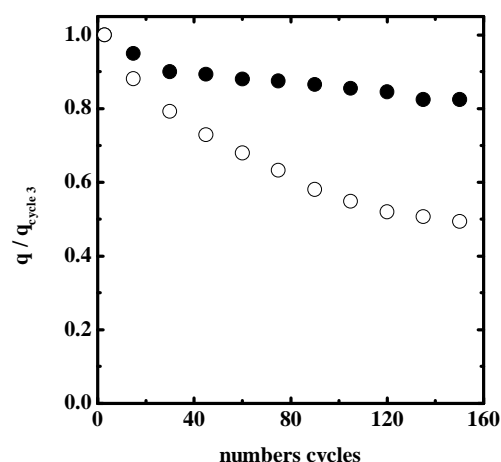

Figure 2 – Variation of the normalized inserted charge as function of the cycle numbers of V_2O_5 ($q_{3°cycle}$ = 8.0 mC cm^{-2}) (open circle) and $[PANI]_{0.3}V_2O_5$ ($q_{3°cycle}$ = 11.2 mC cm^{-2}) (full circle) in 0.5 M $LiClO_4$/PC. v = 5mV/s.